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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO 1008

WARHEADS FOR AIR TARGET GUIDED MISSILES;
TESTING OF

50th Partial Report

RING WARHEAD NO. 137 WITH PUNCH-FORMED NOTCHES;
FRAGMENTATION TEST OF

FINAL Report

Task Assignment NPG-Re3f-607-1-52

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CONFIDENTIAL NPG REPORT NO. 1008

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fiftieth Partial Report

on

Warheads for Air Target Guided Missiles;

Testing of

- -

Final Report

on

Ring Warhead No. 137 with Punch-formed Notches;

Fragmentation Test of

Project No.: NPG-Re3f-607-1-52 Date: JUL 28 1952
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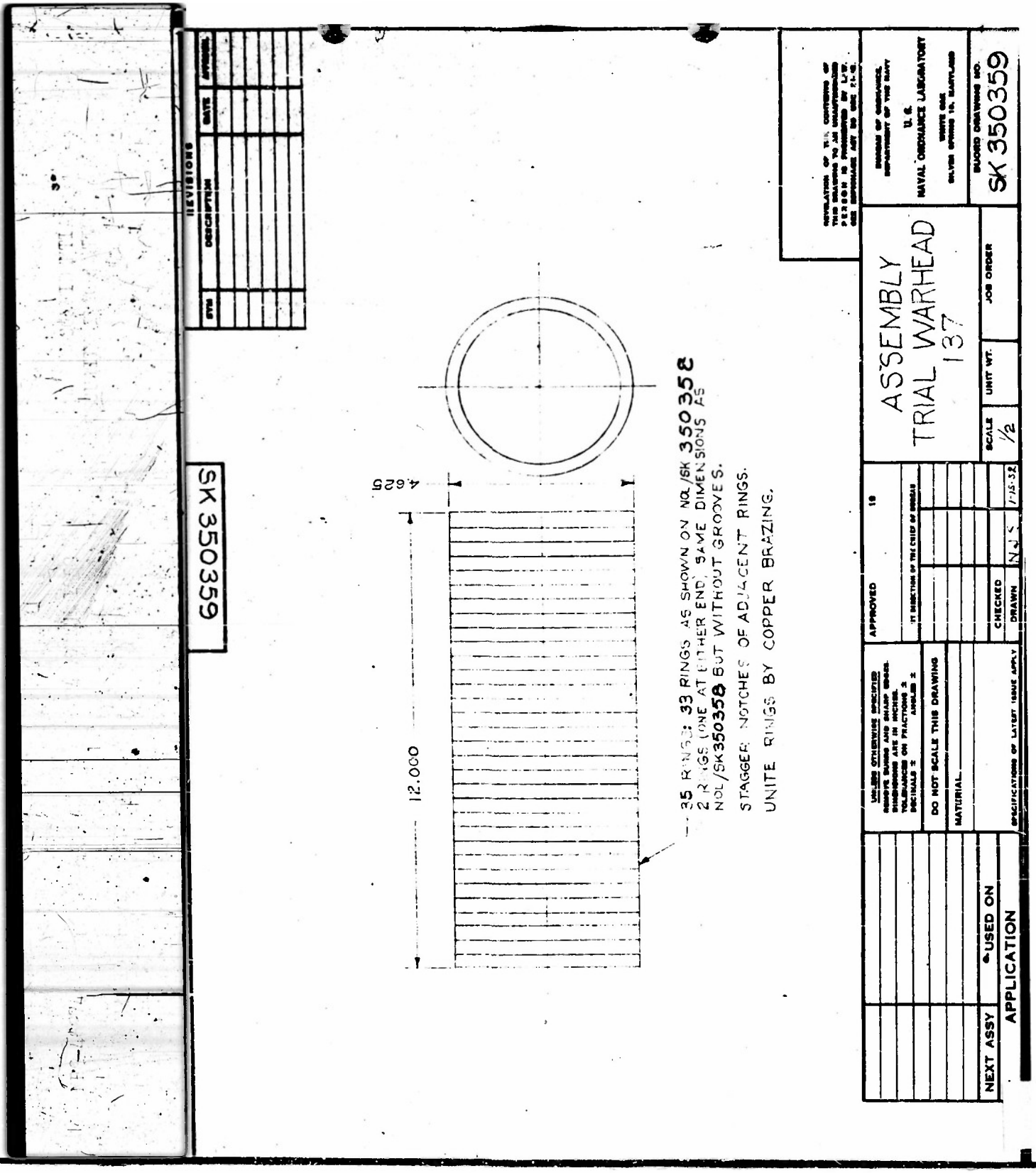

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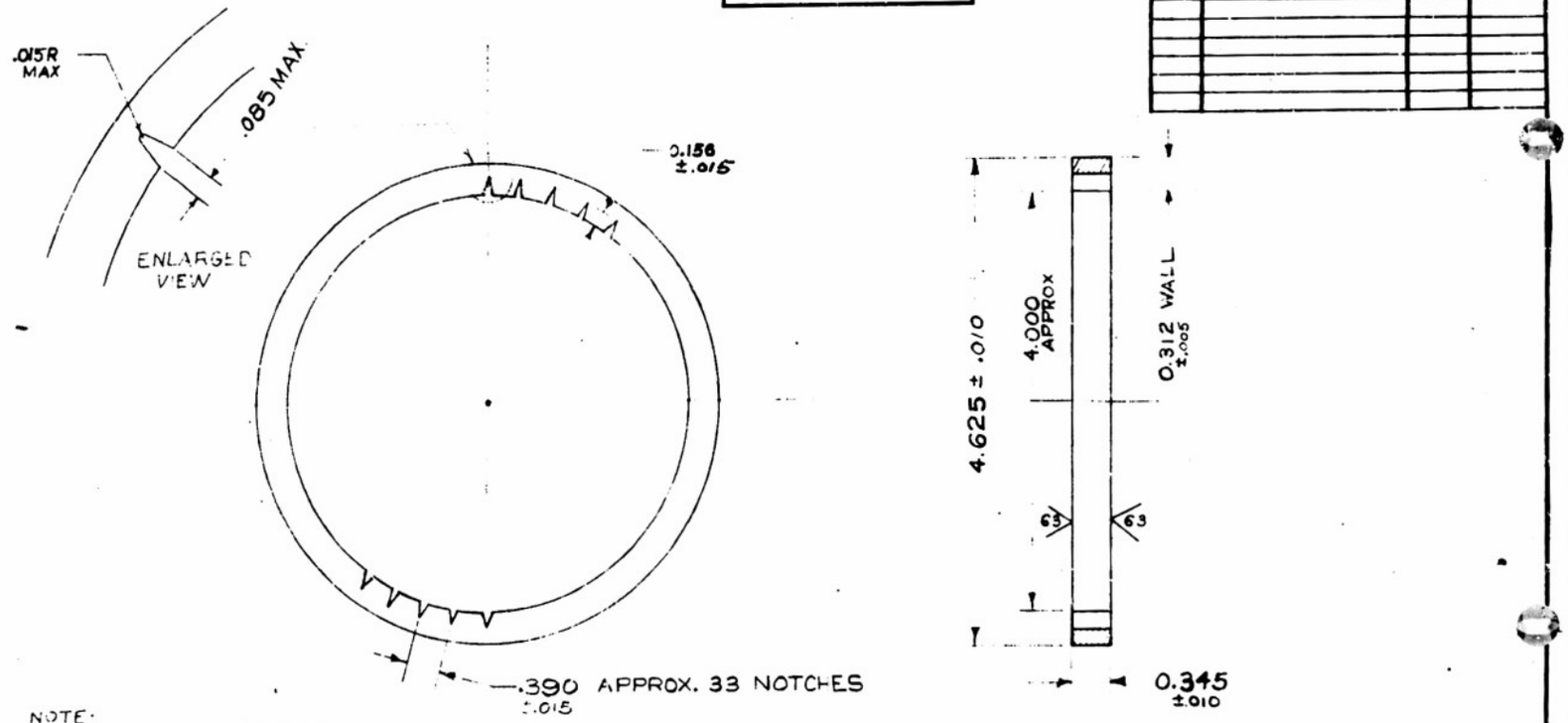

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FRAG. NO. 1648 [redacted] N.P.9 48859

NOL WARHEAD NO. 137

0 - ⅛	Gms.	
	PCS.	
724	Gms.	
⅛ - 1¼	Gms.	
156	PCS.	
136	Gms.	
1¼ - 2½	Gms.	
94	PCS.	
145	Gms.	
2½ - 5	Gms.	
999	PCS.	
3972	Gms.	
5 - 10	Gms.	
127	PCS.	
853	Gms.	
10 - 20	Gms.	
1	PCS.	
12	Gms.	
40 - 80	Gms.	
1	PCS.	
48	Gms.	

SCALE 1"

NP9-48859 24 MARCH 1952 CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of Composition C-3 loaded Warhead No. 137.

FIGURE 3

FRAG NO. 1663 [redacted] N.P.9 49072.

NOL WARHEAD NO 137 -2.

0 - ½	Gms.	
	PCS.	
562	Gms.	
½ - 1¼	Gms.	
194	PCS.	
158	Gms.	
1¼ - 2½	Gms.	
94	PCS.	
151	Gms.	
2½ - 5	Gms.	
784	PCS.	
3229	Gms.	
5 - 10	Gms.	
170	PCS.	
1300	Gms.	
10 - 20	Gms.	
31	PCS.	
315	Gms.	

SCALE 1"

NP9-49072 29 APRIL 1952 CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of Composition C-3 loaded Warhead No. 137-2.

FIGURE 4

FRAG NO. 1454 — NOL WARHEAD NO 137 -3 — N.P.G. 49207

0 - 5/8	Gms.
	PCS.
620	Gms.
5/8 - 1 1/4	Gms.
222	PCS.
174	Gms.
1 1/4 - 2 1/2	Gms.
77	PCS.
131	Gms.
2 1/2 - 5	Gms.
689	PCS.
2857	Gms.
5 - 10	Gms.
207	PCS.
1551	Gms.
10 - 20	Gms.
45	PCS.
568	Gms.

SCALE 1"

NPG-49207 — 7 MAY 1952 — CONFIDENTIAL SECURITY INFORMATION

Mass Distribution of Composition B loaded Warhead No. 137-3.

Ring Warhead No. 137 with Punch-formed Notches;
fragmentation Test of

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Ring Warhead No. 137 with Punch-formed Notches;
Fragmentation Test of

- -

PART A

SYNOPSIS

1. This test was conducted to determine the fragment mass distribution data of 4-5/8" diameter notched ring Warhead No. 137. The notches are formed by utilizing a mechanical punch. This is a cheap and fast method in producing notched rings for controlled fragmentation.

2. a. The punch-formed notches were satisfactory in that all rings fractured at their notches. The copper-brazed bond between rings was too strong, causing some fragments from adjacent rings to remain joined together.

b. Of the three warheads tested, 11 to 35% of the design cubes were in double, triple, and quadruple cube fragments.

Ring Warhead No. 137 with Punch-formed Notches;
Fragmentation Test of

TABLE OF CONTENTS

Ring Warhead No. 137 with Punch-formed Notches;
Fragmentation Test of

PART B

INTRODUCTION

1. AUTHORITY:

This test was authorized by references (a) and (b) and conducted under Task Assignment NPG-Re3f-607-1-52, reference (c).

2. REFERENCES:

a. NOL Conf Work Request WG/16/52 of 13 March 1952
b. NOL Conf Work Request WG/20/52 of 18 April 1952
c. BUORD Conf ltr NP9 Re3f-EJHL:edb Ser 25777 of 18 September 1952

3. BACKGROUND:

a. Reference (c) authorized the Naval Proving Ground to work directly with the Naval Ordnance Laboratory in the development and testing of guided missile warheads.

b. Three Experimental Warheads Nos. 137, containing 33 notched rings and 2 end rings copper brazed together, 4".625 diameter, and 12".0 long were delivered to the Proving Ground for a fragment mass distribution test. The rings of these warheads were notched by a punch-forming method which is a cheap and fast method.

4. OBJECT OF TEST:

This test was conducted to determine the fragment mass distribution data of 4-5/8" diameter notched Ring Warheads Nos. 137. The notches are formed by utilizing a mechanical punch. This is a cheap and fast method in producing notched rings for controlled fragmentation.

5. PERIOD OF TEST:

a.	Dates Project Letters	13 March 1952 18 April 1952
b.	Date All Necessary Material Received	22 April 1952
c.	Date Commenced Test	24 March 1952
d.	Date Test Completed	7 May 1952

6. REPRESENTATIVES PRESENT:

This test was witnessed in part by Messrs. L. E. Hightower and W. D. Sharp representing the Naval Ordnance Laboratory and Hayes Industries Inc., respectively.

PART C

DETAILS OF TEST

7. DLSCRIPTION OF ITEM UNDER TEST:

Three Warheads Nos. 137, 137-2, and 137-3, each 4".625 diameter, 12".00 long, Figure 1, containing 33 rings copper brazed together having internally punch-formed notches, Figure 2, and 2 end rings without notches. All rings were constructed from steel SAE 1010-1020, 4".00 inside diameter, 0".312 wall thickness, 0".345 ring width, notches extended to a 0".156 ± ".015 depth and were 0".39 apart, maximum width of notches were 0".085. Since the spacing of the punch-formed notches varies slightly, the number of notches per ring is not constant. Most rings had 33 notches, but some had 34. This caused imperfect staggering of the notches of adjacent rings and some places the notches were in line. The warheads were designed to produce approximately 1095 cube shaped fragments weighing 4.6 grams each. Warheads were assembled with only one end plate. All three warheads were loaded with Composition C-3 at the Proving Ground. The weight data are as follows:

Warhead No.	Empty Wt. (lbs.)	Comp. C-3 Wt. (lbs.)	Total Wt. (lbs.)
137	13.16	9.33	22.49
137-2	13.61	8.68	22.27
137-3	13.74	8.62	22.36

Ring Warhead No. 137 with Punch-formed Notches;
fragmentation Test of

8. PROCEDURE:

Each warhead was initiated with a Mk 44 auxiliary detonating fuze tetryl pellet (26 grams) and a special engineers blasting cap at the open end of the warhead in a sawdust-filled chamber. After each detonation, the sawdust was sifted and the fragments recovered by the use of sieves and a magnetic separator.

9. RESULTS AND DISCUSSION:

a. The detailed mass distribution data are shown in Figures 3, 4, and 5. The number of fragments in the various weight groups are summarized as follows:

Wt. Group (grams)	No. Fragments #137	#137-2	#137-3
5/8 - 1 1/4	166	194	222
1 1/4 - 2 1/2	94	94	77
2 1/2 - 5	999	784	689
5 - 10	127	170	207
10 - 20	1	31	45
20 - 40	1	0	0

All rings fractured at their notches. The copper braze apparently formed too strong a bond between rings at some locations, causing fragments from adjacent rings to remain together forming double, triple, and quadruple cubes. The number of these are listed as follows:

Warhead No.	Wt. Group (grams)	No. of Fragments Total	Double	Triple	Quadruple
137	5 - 10	127	61	0	0
137-2	5 - 10	170	114	0	0
137-3	5 - 10	207	137	0	0
137	10 - 20	1	0	1	0
137-2	10 - 20	31	2	25	2
137-3	10 - 20	45	11	30	1

The lower number of double and triple cubes obtained on Warhead No. 137 may be attributed to its slightly higher charge-weight ratio, or to a weaker brazing bond.

Ring Warhead No. 137 with Punch-formed Notches;
fragmentation Test of

b. Practically all of the design number of cube fragments were accounted for in the 2 1/2 to 20 grams weight group with the following percentages in the double, triple, and quadruple cube groups:

Warhead No.	% of Design Number		
	Double	Triple	Quadruple
137	11	0.3	0
137-2	21	6.8	0.7
137-3	27	8.2	0.4

PART D

CONCLUSIONS

10. a. The punch-formed notches were satisfactory in that all rings fractured at their notches. The copper-brazed bond between rings was too strong, causing some fragments from adjacent rings to remain joined together.

b. Of the three warheads tested, 11 to 35% of the design cubes were in double, triple, and quadruple cube fragments.

Ring Warhead No. 137 with Punch-formed Notches;
Fragmentation Test of

The tests upon which this report is based were conducted by:
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